LISBON
SCHOOL OF
ECONOMICS &
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UNIVERSIDADE DE LISBOA

MASTER

DEVELOPMENT AND INTERNATIONAL COOPERATION

MASTER´S FINAL WORK

DISSERTATION

AWARENESS AND ATTITUDES TOWARDS ENVIRONMENTAL ISSUES AMONG STUDENTS. THE PARENTS' ROLE.

BERNARDO FILIPE NUNES GRAÇA

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SUPERVISION: PROFESSOR ELSA MARIA NOBRE DA SILVA FONTAINHA

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ABSTRACT

The present thesis aims at comprehending the young's formation of awareness and attitudes towards environmental issues, stressing the parents' role.

This work uses the microdata for PISA Portugal 2015, comprehending four questionnaires addressed to: students (N=7325) and respective parents, schools and teachers. The empirical analysis takes advantage of comparable questions in the students' and parents' questionnaires.

The results, obtained via linear models and correlation analyses, show a higher transmission of parental preferences in the attitudinal component than in the awareness aspects. Student and parental characteristics show a major role performed by these agents, as opposed to the lack of significance showed for school and teacher characteristics.

Student's enjoyment of learning science and a higher expected future educational level are predictors that affect positively environmental awareness and attitudes. It is furtherly suggested that girls correlate heavier with their parents than boys and mothers correlate heavier with their children than fathers. As for household characteristics the cultural resources and books plays a part, especially concerning female students. For male students, the household income and other materialistic resources appear to have a higher importance in both awareness and attitudes. The parents' educational attainments only favour the students' awareness not showing significance for the attitudes.

KEYWORDS: PISA; Intergenerational Transmission of Preferences; Awareness; Attitudes; Parental Influence; Environment; SDG.

JEL CODES: I21; I25; J62; O15; Q01; Q56.

RESUMO

A presente dissertação visa explicar a formação de atitudes e consciência dos estudantes em relação às questões ambientais dando enfoque ao papel dos pais.

A amostra utiliza como fonte os microdados PISA Portugal 2015, baseados em quatro questionários: o dos estudantes (N=7325) e dos respectivos pais e ainda da escola e dos professores. A análisa empírica tira partido da existência de perguntas iguais ou comparáveis nos questionários dos estudantes e dos pais.

Os resultados, obtidos com base em modelos lineares e análises de correlação, revelam uma transmissão de preferências parentais mais forte na componente atitudinal, do que na relativa à consciência. As características pessoais de pais e estudantes possuem poder explicativo, ao contrário das características da escola e dos professores.

O prazer na aprendizagem científica e a expetativa de um maior nível educacional no futuro são fatores que afetam positivamente a consciência e atitudes ambientais. Conclui-se, também, que as raparigas em comparação com os rapazes apresentam uma maior correlação com atitudes e tomada de consciência dos progenitores. As atitudes e tomada de consciência ambiental das mães, quando comparadas com a dos pais, relacionam-se mais com as dos filhos e filhas. Os recursos culturais e o número de livros disponíveis no agregado familiar mostraram-se significativos na explicação de atitudes e consciência ambiental, em especial para as estudantes, pelo contrário, para os estudantes do sexo masculino, são os rendimentos familiares e outros recursos materiais. Os níveis educacionais dos pais favorecem a consciência ambiental dos estudantes não se refletindo nas atitudes.

PALAVRAS-CHAVE: PISA; Transmissão Intergeracional de Preferências; Consciência; Atitudes; Influência Parental; Ambiente; ODS.

CÓDIGOS JEL: I21; I25; J62; O15; Q01; Q56.

AOS ESFARRAPADOS DO MUNDO E AOS QUE

NELES SE DESCOBREM E, ASSIM DESCOBRINDO-SE,

COM ELES SOFREM, MAS, SOBRETUDO,

COM ELES LUTAM.

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ACKNOWLEDGMENTS / AGRADECIMENTOS

Gostaria de agradecer à Professora Elsa Fontainha pela orientação e disponibilidade ao longo de todo este processo.

Gostaria igualmente de agradecer à minha família, à Camila e às pessoas com que convivi ao longo destes anos nesta faculdade.

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF ABBREVIATIONS

DESD	Decade of Education for Sustainable Development
EAI	Environmental Attitudes Index
IAVE	Instituto de Avaliação Educativa
MDG	Millennium Development Goals
NEP	New Environmental Paradigm
OECD	Organisation for Economic Co-operation and Development
PISA	Programme for International Student Assessment
SDG	Sustainable Development Goals
SPSS	Statistical Package for the Social Sciences
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization

1. INTRODUCTION

The Fourth United Nations' (UN) Sustainable Development Goals (SDG) for 2030 states the need to "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". Without quality education many other SDG cannot be fulfilled, hence why this need has an overarching importance[1] (Richardson & UNICEF, 2018). The agenda's success requires major investments at world-wide development and international cooperation fora. There is no accomplishment without education, and there is no education without the involvement of its main agents.

As stated by the European Commission (1995, p.11), there's a need to build **awareness on scientific and environmental issues** on the younger generations for them "to fulfil an enlightened role in **making choices** which affect their environment and to understand in broad terms the social implications of debates between experts" (Eagle, Low, Case, & Vandommele, 2015; Organisation for Economic Co-operation and Development, 2013, 2018).

The present thesis aims at comprehending the mechanisms behind the young's formation of awareness and attitudes towards a sustainable future, stressing the parents' role to provide the opportunities and to shape their children to be able to face these major challenges.

The way parents influence their children, specially by role-modelling, studied under Intergenerational Transmission of Preferences, Attitudes, and Behaviours theories (Bisin & Verdier, 2000, 2001a, b) offers precious insights on the individual subsequent interactions and perceptions. Bisin and Verdier's (2001a) model of intergenerational cultural transmission, gives the economical approach to these matters. The model characterizes parents' relationship with their children by looking at which traits or skills the parents pass on according to their predictions on the children's future payoff.

Parental choices within their economic and time **resources** influence their child's **perceptions** in many ways (Bulte & Horan, 2011; Leibowitz, 1974; Webley & Nyhus, 2006). The **socioeconomic status** (Duarte, Escario, & Sanagustin, 2017), the **family**

[1] https://en.unesco.org/education2030-sdg4

structure and background (Astone & McLanahan, 1991; Ermisch & Francesconi, 2001), the **neighbourhood** environment (Bronfenbrenner, 1979; Manski, 1993), as well as the level of investment in "monitoring, disciplinary, nurturing and expectational environment" (Haveman & Wolfe, 1995, p.1837) the guardians put on to the next generation act as drivers for the choices and opportunities the child has in the present and future (Heckman & Masterov, 2004; Kan & Tsai, 2005).

The **social context**, as a strong contributor for the awareness and attitudes of students must not be neglected (Giddens, 1997, p. 41; Stern, Dietz, & Guagnano, 1995). As Klaczynski and Reese (1991) observed, there is evidence supporting that students' attitudes differ according to their educational tracks and **peer** contexts (Hanushek & Woessman, 2007; Manski, 1993; Sacerdote, 2011).

In the light of the above, Björklund and Salvanes (2011) and Haveman and Wolfe (1995, p.1836) organized the predictors of **children educational attainments, fertility choices and work-related achievements** in three domains: (i) the **governmental** choices, from which depends equality of opportunities ("the social investment in children"); (ii) the **parental** choices in the investment to their offspring in terms of quantity and quality ("the parental investment in children"); (iii) and the **self**-choices given the inputs they receive from the former and their efficiency skill on them. These sets of choices count to establish a complete picture of the **individuals' environment**.

In this sense, Bronfenbrenner's (1979) Ecological Systems Theory provides a psychological approach for this dissertation. The analysis of the theory's layered approach empowers this research with a capability to picture a hierarchy of the agents that compose the child's environment. Starting from the ***microsystem***: parental and family interactions; to the ***mesosystem***: school, curricula, teaching methods, peers and neighbourhood environments; allows for the extrapolation for the ***exo-*** and ***macro-system*s**: school administering institutions (exo-) and cultural, social or legal norms (macro-).

Thus, the following **research questions** have a pressing purpose: Are parents the main influencers in children's awareness and attitudes towards environmental issues? What are the roles of schools, teaching method and curricula, peers and neighbourhood in the increment of awareness and pro-environmental attitudes?

Taking advantage of the Programme for International Student Assessment (PISA) (OECD, 2016) database, which include information for 15-years-old students, their parents, schools, and teachers, the empirical strategy comprehends statistical analysis and econometric regression in order to answer the previous interrogations.

Using information collected by PISA in Portugal for the year 2015, the study contributes to shed light on the future actors and subjects of the UN 2030 agenda.

The importance of these contextual variables - parental, school and other social settings - and their availability in large databases, like the Programme for International Student Assessment (PISA)[2], that gather this kind of information bring credit as well as reliability to the academia on the subject (O'Flaherty & Liddy, 2018; OECD, 2016).

Efforts made in order to design a picture of the degree to which the **leaders of tomorrow** are prepared to face novel settings and take part in an environmentally friendly and sustainable world have a relevant pertinence. Students that answered PISA 2015 are the agents of change of tomorrow and within that rationale their mindset resembles the mindset of our future.

This dissertation seeks to add value to previous literature on some lacunas that were identified at different levels. And aims to accomplish this by:

- Describing and interpreting the roles of the agents of change, such as parents, schools, and peers, in the Portuguese students' reality;
- Analysing the way education, directly or indirectly, contributes to the promotion of the environment;
- For the first time, as far as the author knows, researching the relationships between parents' and adolescents' attitudes and awareness towards environment assessing the exact same questions in PISA questionnaire.

The present work follows, *in section 2*, with the review of two strands of the literature that this research connects: first, at the macro level, the SDG and education (institutional context and international policy benchmarks); second, a clarification on the main concepts and theories on intergenerational transmission of preferences, attitudes and

[2] http://www.oecd.org/pisa/

behaviours. The main literature regarding the agents of change (students, parents and teachers) and the context (school, curricula, and teaching method; and peers and neighbourhood) is examined. Furthermore, a brief elucidation on Bronfenbrenner's (1979) Ecological Systems Theory and its relationship with the agents influence. S*ection 3* describes PISA's scope and goals, presents the main database, its construction and idiosyncrasies and the empirical strategy adopted. *In section 4*, the results are shown and discussed. *Section 5* concludes, discusses limitations and suggests further research avenues.

2. LITERATURE REVIEW

Most of the SDG are only possible with sustained educational increments[3]. This education is only possible through in-depth action which creates awareness and mobilizes new generations. In this way, all the agents, especially parents as major influential authorities, and societies must be compromised. Recently, Richardson and UNICEF (2018) published findings concluding that families, as the innermost unit of a society, when properly attended can be the most effective propeller of change and innovation. Thus, family policy and educational increments in the parents' capabilities will influence their families driving the world towards the fulfilment of SDG commitment.

This section gathers contributions from economics, education, sociology and social psychology in order to summarize the state-of-the-art findings that relate the research on sustainable development issues, focusing on environment-related matters, to the societal agents' behaviours and influential patterns.

2.1. Sustainable Development Goals and Education

International organisations have , since the turn of the century, established commitments and goals towards improving primary education, literacy, inclusivity and quality in education. UN's established Millennium Development Goals (MDG) in 2000, offered a refreshed and comprehensive framework for the world to pursue its most urgent

[3] https://en.unesco.org/education2030-sdg4

concerns until 2015, ranging from poverty eradication to the development of global partnership for development[4]. It's second goal "Achieve universal primary education" was the educational mantra and was able to reach some important improves: increase from 83% (2000) to 91% (2015) the level of enrolment in primary education in developing regions; between ages 15 to 24 increase the literacy from 83% (1990) to 91% (2015), decreasing the literacy gender gap. However, the percentage of out-of-school children increases from 30% in 1999 to 36% in 2012.

Parallelly and complementarily, United Nations Educational, Scientific and Cultural Organisation (UNESCO) led the Education For All movement created at the Dakar World Education Forum 2000 (UNESCO, 2000) and the UN's Decade of Education for Sustainable Development (DESD) 2005-2015 (UN, 2003). Additionally, UN established the Literacy Decade: Education for All (UN, 2002). The need to fight for quality education is never-ending and UN gave new strength to the plan for action by adopting, in 2015, the "Transforming our world: the **2030 Agenda for Sustainable Development**" resolution (UN, 2015). This framework comprises 17 goals divided in 169 targets and builds on the former agendas to answer what these failed to accomplish.

The fourth goal (SDG4) "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UN, 2015, p.14) has at its foundation its target 7 "Education for sustainable development and global citizenship" aiming to ensure that, by 2030, "all learners acquire the **knowledge and skills** needed to promote sustainable development, including, among others, through **education for sustainable development and sustainable lifestyles**, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development" (UN, 2015, p.17).This ought to be measured by the "extent to which (i) global **citizenship education** and (ii) **education for sustainable development**, including gender equality and human rights, are mainstreamed at all levels in: (a) national education policies, (b) **curricula,** (c) **teacher education** and (d) student assessment" (UN, 2017, p.8).

[4] http://www.un.org/millenniumgoals/

UNESCO, starting at the 2015 Incheon Declaration[5], compromised to lead the SDG4 and to take part, consequently, on the fulfilment of all the other SDG through its education components. The interrelation among all SDG and the crucial role played by the family within Education Goals is stressed in the literature (UNESCO,2018).

These matters widespread since the landmark of the Equality of Educational Opportunity, conducted at the USA, known as the Coleman Report (Coleman et al., 1966) and have maintained relevance until today.

2.2 Knowledge, Awareness, Attitudes and Behaviours: Concepts, Interdependence and Determinants

2.2.1 Concepts, measurements and interrelations.

Knowledge, attitudes and behaviours concerning a specific topic or problem, for example an environmental problem, can be evaluated by different ways. Because the scope of this dissertation is on the awareness and attitudes of the Portuguese students concerning environmental issues the concepts involved must be presented and discussed. Additionally, because actions ('behaviours') are needed to attain the SDG, some literature regarding the links among knowledge-attitudes-behaviour is analysed.

The **definition of attitudes** is yet to be consolidated for the academic as well as for the lay people. However, the importance of psychosocial variables appears to have an undiscussed importance in behaviours (Biasutti & Frate, 2017; Duarte et al., 2017). Milfont (2007, p.12) defines **environmental attitudes** as "a psychological tendency that is expressed by evaluating perceptions of or beliefs regarding the natural environment, including factors affecting its quality, with some degree of favour or disfavour". According to Bybee and McCrae (2011) the **formation of attitudes** comes from the realities that each person faces by being part in social engagements and societal interactions. Throughout their development individuals form cognitions, feelings and inclinations that reflect and fundament their attitudes.

[5] https://en.unesco.org/education2030-sdg4

The results from the New Environmental Paradigm (NEP) (Dunlap & Van Liere, 1978), one of the first and most widespread **measuring instrument** in the academia focusing on environmental attitudes, concluded that **attitudes and behaviours** not only don't go hand-in-hand but also regularly contradict (Eagle et al., 2015; Pe'er, Goldman, & Yavetz, 2007; Stern et al., 1995). This conclusion is reinforced by Kollmuss and Agyeman (2002) based on a theoretical analysis of earlier published analytical frameworks to explain this gap which modelled the way internal factors - knowledge, attitudes, values, and emotional involvement – and external factors – patterns of behaviour, social norms, and other social and cultural factors – mutually overlap. Moreover, Michalos and colleagues (2012) reinforced the presence of a not linear relation between **SD knowledge, attitudes and behaviours** by testing 1,551 tenth-grade students from Manitoba, Canada. They observed, through the composition of three indexes, a 30-item Knowledge Index, a 15-item Attitudes Index, and a 15-item Behaviours Index, evidence that **knowledge and attitudes contribute to a change in behaviour** in students, however this only counts for 21% of the explained variance which suggests that, to some measure, the relationship between the indexes may be defective.

Pe'er and colleagues (2007) and Kollmuss and Agyeman (2002) worked on solving and mapping the complex and not linear relationship involving knowledge, attitudes, and behaviours. The latter further draw a model showing a multi-sided array of obstacles, ranging from emotional variables to the social and family context, as shown in Figure 1.

The authors observed a significant number of obstacles between internal and external factors, such as values, knowledge and feelings towards environment, and a pro-environmental behaviour, *de facto*. Determinants such as inertia to change learned behaviours, lack of public and cultural incentives as well as emotional blockings harm the connections required to pursue a definite change in existing behavioural patterns towards environment.

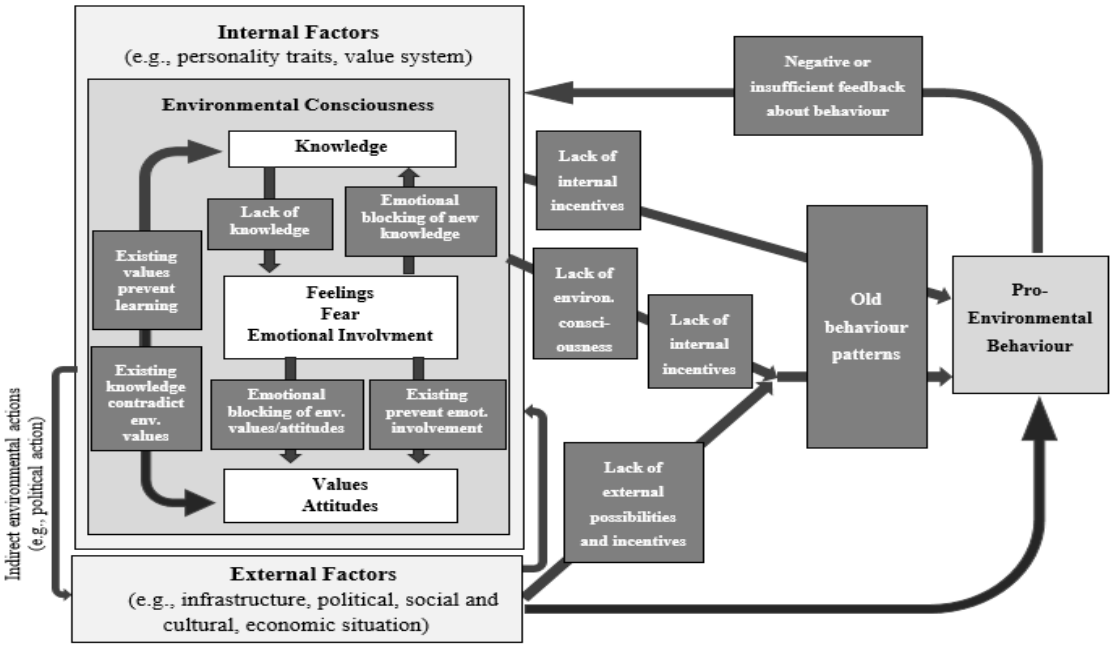

Figure 1. Model of pro-environmental behaviour. Author's construction adapted from Kollmuss and Agyeman (2002, p.257).

Pe'er and colleagues (2007) also observed an above-expected gap between knowledge and attitudes. Despite showing favourable attitudes towards environment, the level of knowledge and awareness was very limited. This may be caused by normative influences or social desirability effects.

More recently, Dijkstra and Goedhart (2012) observed a **weak** link between knowledge and awareness toward **climate change and other environmentally** related concepts, and the corresponding attitudes and behaviours.

The **attitudes towards science**, come from the formal and informal experiences individuals undertake whether it is through **formal school-related activities, the media, visits at museums** or other science-related institutions. The **scientific literacy** is defined as a fourfold ability comprehending: (i) a context component, identifying the presence of scientific phenomena; (ii) a knowledge component, in "understanding the natural world"; (iii) a competency component, demonstration and application of knowledge in arguments; and (iv) an attitudinal component, which account for "interest in science, support for scientific enquiry, and motivation to act responsibly" (Bybee & McCrae, 2011, p.9) . As resumed in the Figure 2.

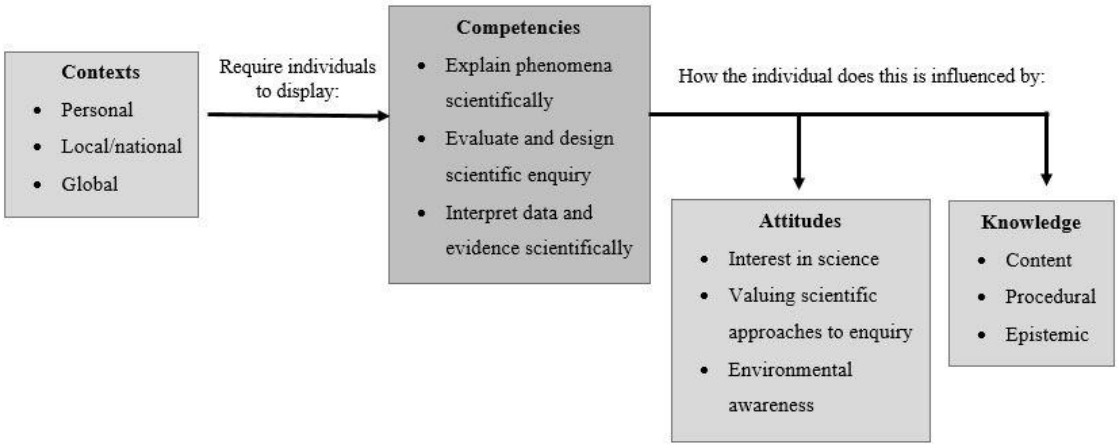

Figure 2. "Inter-relations between the four aspects".
Author's construction adapted from OECD (2016, p.23).

Moreover, despite the need for scientific knowledge gain there must be a connection between scientific literacy and the **beliefs and attitudes** the young possess that make the bridge between the concepts and their willingness to follow such values **(**Bybee & McCrae, 2011). However, Kollmuss and Agyeman (2002) argue that environmental education is not sufficient to attain a pro-environmental behaviour, because there is no automatic progressions from knowledge to attitude and from attitude to behaviour.

2.2.2 Parents and family background.

"Over the past years, the involvement of parents in education has gained importance in the education debate, and to some extent it has also become relevant for education policy. Parents are not only an important audience, but powerful stakeholders in education" (OECD, 2016, p.117). Many social scientists call the attention for the relation parent-child impacts (Becker, 1991; Giddens, 1997; Hampden-Thompson, Guzman, & Lippman, 2013).

The imprinting of **preferences, beliefs and values** that translate into cognitive as well as non-cognitive skills can be seen through the eyes of a cultural transmission approach. This approach argues that, on the one hand, parents can imprint their own preferences and skills onto their children motivated by a "paternalistic altruism" (Bisin & Verdier, 2000, p. 962) – **models of imperfect empathy** – which, in the present study, would be accounted by the transmission of similar awareness levels and attitudes. On the other hand, parents imprint certain preferences that they consider to be the maximizing skills

for the children's future payoff whether are their own construct or not – **model of perfect empathy** – where the awareness levels and attitudes would be higher and more pro-environment, respectively, than the parents' ones (Bisin & Verdier, 2000, 2001a, b). This approach will be necessarily a function of both past behaviour analysis and future expectations by the agents, in this case, the perfectly empathetic parents (Bulte & Horan, 2011).

Furthermore, the importance of parental time allocation and the effects on children's attainments and behaviour is well documented (e.g. Cardoso, Fontainha, & Monfardini, 2010; Hampden-Thompson et al., 2013; Leibowitz, 1974; Mancini, Monfardini, & Pasqua, 2017).

Leibowitz (1974) concluded that parental inputs of time and resources, designated as home investment, are not just relevant to the **child's ability** but are of greater importance, when compared to genetic endowments. The author concluded that the **mother**'s level of schooling affects the ability of the child whereas the **father**'s does not, which points to a significant input given on the time of home investment rather than on genetic factors. If both had the same relevance, both **parents' education** would be equally relevant to the children (Grönqvist, Öckert, & Vlachos, 2017). Cardoso and colleagues (2010) also found a predominance of mother influence in the self-investment in human capital by adolescents in Italy, France and Germany.

Pe'er and colleagues (2007) concluded a very strong effect on the levels of environmental knowledge and attitudes from the **mother's educational status**. The **father's educational status** is argued to be more directly linked to professional indicators, such as income and employment status (Leibowitz, 1974). Cunha and Heckman, (2007) also state that the **intergenerational transmission of preferences** and the influence that parents have on the formation of the offspring's own choices must take into due account the investment in parental time use.

Webley and Nyhus (2006, p. 160) argue that "future **orientation (and conscientiousness) of parents** is correlated with that of their children is evidence that this fundamental approach to **economic matters** is transmitted from parents to children, though how this takes place is unclear". These correlations, despite weak in many cases, are a hint to understand that, as smoking or drinking behaviours, also attitudes towards

long term challenges and delay gratification behaviours as the ones emerging from the sustainable development paradigm can have similar trends (Webley & Nyhus, 2006). The fact that **sustainable behaviours** and their effect in the world are not short-term, or at least immediate, suggests that the kind of parental influence transmitted towards future orientation, willingness to save and **other long-term economic issues**, has somewhat in common with the scope treated in this investigation (Strathman, Gleicher, Boninger, Edwards, 1994).

A constraint of the transmission of preferences and endowments to children reflects on the cultural capital that the older generation possesses, prompted by the **socioeconomic status of the parents.** Also, the willingness to pass on these **resources** reflects to large extent on the achievement of children even when socioeconomic characteristics are accounted for (Xu & Hampden-Thompson, 2012). Similar evidence is found in relation to the **science attitudes and behaviours** from the parents that associate positively with the ones of their children (Perera, 2014).

Additionally, the **family structure** may have yet another reflex on the children, being that evidence on one-parent and two-parent families suggests that the emotional deprivation encouraged by scarcity of time or willingness to give stimuli to children may be related to under-performing students as well as **below-potential civic and literacy performance** (Astone & McLanahan, 1991; de Lange, Dronkers, & Wolbers, 2014; Ermisch & Francesconi, 2001; Hampden-Thompson, 2009; Sandefur, McLanahan, & Wojtkiewicz, 1992). Astone and McLanahan (1991, p.318) argue that "children from non-intact families report lower educational expectations on the part of their parents, less monitoring of school work by mothers and fathers, and less overall supervision of social activities than children from intact families. An exception is the fact that children in single-parent families spend significantly more time talking to their parents than children in two-parent families". Besides, the authors find evidence of effects from family structure changes on the quality of parental involvement with their children and with the school their children attend (and with feelings of disengagement from school from the young).

The **parents' educational attainments and income** levels have an influence on their potential wealth, which reflects on their resources to give their children an optimal level

of educational opportunities. Therefore, the educational level attained by the parents correlates heavily and predicts the level of educational attainment of their children (Becker, 1991; Ermisch & Francesconi, 2001; Hampel, Holdsworth, & Boldero, 1996; Heckman & Masterov, 2004; Tabellini, 2008). Hertz and colleagues (2007) further studied this correlation by analysing a 50-year trend on 42 countries around the world registering a persistent average correlation coefficient on levels of schooling of parents and their children of $r = .40$, with $r = .39$ for the Western European average (ibid., p.25).

Hampden-Thompson and colleagues (2013) studied a cross-country analysis on the relationship between students' educational attainments and the degree of **parental involvement** applying a Bronfenbrenner's (1979) Ecological Systems theoretical framework (presented at point 2.2.5.) and an Item Response Theory (IRT) technique. The study, using PISA microdata for 2000, confirmed the importance of parental involvement, as supported by Hampel and colleagues (1996). The authors also observed, however, that higher parental involvement can have a negative correlation with educational outcomes, which can be interpreted as parental monitoring due to poor school performance.

Being the **attitudes** an output of formal and informal experiences, a major input as to do with the actuation of **family and parental investment** in their offspring (Hampden-Thompson et al., 2013). According to Bronfenbrenner's (1979) Ecological Systems Theory this would count as a microsystem's influence on children having exclusivity on the first phase of development and modelling the infant.

Duarte and colleagues (2017) observed from a PISA 2006-based study for European students that the **socioeconomic status, the level of education of the parents, and the number of books at home**, interpreted as a "proxy for the 'scholarly status at home' or 'home literacy environments'" (ibid., p.35), had a strong positive effect on the *Environmental Attitudes Index (EAI),* built on the basis of the level of agreement given by the student to seven statements (ibid., p.28). The authors argue of the presence of evidence on intergenerational transmission of environmental attitudes, and the amount of communication at home regarding these topics are relevant.

Eagle and colleagues (2015) and Grønhøj and Thøgersen (2012) observed that family influences impact children's own patterns and their environmental behaviours. The authors conclude that there's a high correlation between the children's perceived parental

behaviour towards environmental practices and the children's own attitudes and behaviour.

Perera (2014), in a PISA 2006-based study on 15 countries, examined the extent to which the **parents' interest in science** phenomena influences their children's own interest and their result in science school-performance. The conclusions not only found a statistically significant effect on the science-related attitudes of the younger but also on their scores. Another important finding suggests that the effect that parents' interest provokes on their children is equal on both **poorer and richer backgrounds**.

Therefore, there is strong evidence from the above mentioned literature that parents play more than an important part in producing ***cognitive and non-cognitive skills***, as behaviours, attitudes and knowledge, in their children since a tender age in order to boost both awareness and attitudes that may provide social and economic success[6] (Carneiro & Heckman, 2003; Grönqvist et al., 2017; Hampel et al., 1996; Heckman, Stixrud, & Urzua, 2006).

"Noncognitive abilities (perseverance, motivation, time preference, risk aversion, self-esteem, self-control, preference for leisure) have direct effects on wages (controlling for schooling), schooling, teen pregnancy, smoking, crime, performance on achievement tests, and many other aspects of social and economic life" (Cunha & Heckman, 2007, p. 32). Furthermore, several authors show a propellant effect of non-cognitive skills on the ability to develop cognitive ones (Grönqvist et al., 2017; Hampel et al., 1996). However, Lundberg (2017), despite reinforcing the importance of non-cognitive skills to economic success and well-being, argues that the effect on labour market outcomes is only made through education.

Evidence shows that non-cognitive skills are most important for individual development which transpose personal and societal success (Almlund, Duckworth, Heckman, & Kautz, 2011; Grönqvist et al., 2017; Heckman et al., 2006; Lundberg, 2017).

Parental influence spreads through several contexts that the young must be prepared to face and shape, in some way, their perceptions. Kelly (2006) points at the civic

[6] See Cunha, Heckman, Lochner and Masterov (2006) for more on Human Capital Formation.

behaviour, translated by the voting and volunteering behaviours and the mimicking of the next generations of these behaviours.

This parent and family influences compete with a multitude of other messages received by children, whether it is at **school** (Bergman, 2016; Card, Domnisoru, & Taylor, 2018; Hanushek, 2011) or at **peer interactions** (Duarte et al., 2017; Giddens, 1997; Sacerdote, 2011). Both school and peer interactions will be presented, respectively, in 2.2.3. and 2.2.4. points.

2.2.3 School, curricula and teaching.

Having examined the role of parents in the awareness, attitudes, and behaviours of students, it comes as appropriate to analyse how formal education can help to mitigate the discrepancy between attitudes, knowledge, and behaviour.

Karpudewan, Roth, and Chandrakesan (2015) observed that scientific and environmental knowledge can be damaged by **misconceptions caused by a flawed teaching method**. To the authors, an overemphasis on memorising teaching practices that can be solutioned by the increment of constructivist teaching[7] in schools, mitigating misconceptions and cleaved scientific values and beliefs (Coertjens, Boeve-de Pauw, De Maeyer, & Van Petegem, 2010; Hampel et al., 1996). Furthermore, Cunha and Heckman (2007) argue that **emotional skills** promote learning, referring existing evidence relating cortisol levels to stress which can interfere with cognitive skills. This argument is in line with PISA framework which by the assessment construct "does not just ascertain whether students can reproduce knowledge" but also if "students can **extrapolate** from what they have learned and can **apply that knowledge** in unfamiliar settings, both in and outside of school" (OECD, 2018, p.3).

Olsson, Gericke, and Chang Rundgren (2015) also detected the complexity of these environment related concepts using a difference-in-differences technique applied to 1,775 Swedish students from the sixth and ninth grades. The authors observed a small effect on the group to which additional lecturing focusing on these subjects was held when compared to the **control group** with **standard curricula**.

[7] For more on the subject see Alsop and Watts (2003) and Osborne, Simon, and Collins (2003).

By conducting an **environmental education initiative**, Lake Superior Stewardship Initiative, implemented at multiple Michigan schools, USA, for 432 students, Bergman (2016) observed effects after one year of **Environmental Education** in the awareness of the potential to impact nature, but that there was a need for a longer-term experience to increase the levels of **environmental appreciation and intentions for environmental learning and behaviour**.

Coertjens and colleagues (2010) conducted a PISA 2006-based study on Flemish students in which observed an explained variance from school and teaching approach effects on 6.5% on **Environmental Attitudes** and 17% on **Environmental Awareness**. This suggests that, schools may interfere more on the awareness and knowledge gain of their students than on the attitudinal component, being this one more permeable to the **social and family context**.

The authors concluded that "schools can stimulate students' environmental awareness by teaching in a more hands-on manner" (Coertjens et al., 2010, p.516), arguing for a constructivist approach to teaching as well as diversifying the range of stimuli that schools offer children in order to increase the effect on attitudes.

The scientific literacy, as defined previously in point 2.2.1, **helps to build in concepts and form judgements** on **environmental** concepts which are then **filtered by** "the critical cognitive components of an attitudinal system consist of beliefs that result in **making evaluative judgements** such as favourable or unfavourable, good or bad, desirable or undesirable, towards a referent, in this case science" (Bybee & McCrae, 2011, p.13).

Evidence shows that **school quality measures** have a very significant effect on upward mobility and acquisition of **cognitive and non-cognitive skills**, giving special resonance to literature saying that government intervention, such as teacher salaries, are relevant for the level of mobility particularly on children from poor-educated backgrounds and minorities (Card et al., 2018; Hanushek, 2011). In this regard, Hanushek, Rivkin and Schiman (2016) observed the effect that **teacher turnover** has on student achievement. They recorded "a turnover-induced loss of general and grade-specific experience that is sufficient to offset the potential gains that come from the departure of teachers who on average are less effective than stayers."

2.2.4 Peers and neighbourhood

The definition of peer effects is a difficult one. Sacerdote (2011, p.250) adopting a broad one stated that "peer effects is used to encompass nearly any externality in which peers' backgrounds, current behaviour, or outcomes affect an outcome".

Peer effects seem to be "positive, significant, and important in size, meaning that the environmental attitudes of a particular student are reinforced by the attitudes of school-grade peers" (Duarte et al., 2017, p.36). Literature further refers that girls have more pro-environmental attitudes than boys (Coertjens et al., 2010; Duarte et al., 2017). Notably, Duarte and colleagues (2017) observed that Portugal scored the highest among European countries on the author's environmental attitudes index (EAI).

Although peer effects seem to influence less the test scores than other variables their major area of influence appears to be the proneness to foment deviant behaviours (e.g. drinking, teen-pregnancy). Peers, as argued by Sacerdote (2011), affect more the **attitudinal** component than the cognitive one.

2.2.5 Bronfenbrenner's (1979) Ecological Systems Theory.

The contextual factors are frequently included as explanatory variables in economic models. A psychological approach on these matters comes from Bronfenbrenner's (1979) Ecological Systems Theory stressing the influences and interactions between the individual and the context.

Human development is defined by the author as "the process through which the growing person acquires a more extended differentiated, and valid conception of the ecological environment, and becomes motivated and able to engage in activities that reveal the properties of, sustain, or restructure that environment at levels of similar or greater complexity in form and content" (Bronfenbrenner, 1979, p.27). A clarification of the terminology is necessary: the term '*ecological environment*' is used here in a broad sense, concerning the social environment of the individual and not on sustainability matters.

The author organizes the environment in multiple structures or "*systems*", in a layered disposition, which is the sum of the structures *plus* the interaction between them. The

innermost structure, the ***microsystem***, is defined as "a pattern of activities, roles, and interpersonal relations experienced by the developing person in a given setting with particular physical and material characteristics" (Bronfenbrenner, 1979, p.22). For the present dissertation this is considered as the in-home interactions, namely parental and family environment. The author also recognizes the importance of ***bidirectional processes of interchange*** at this level, existing change provoked by the parents as well as by the children on both.

The second structure, the ***mesosystem***, "comprises the interrelations among two or more settings in which the developing person actively participates (such as, for a child, the relations among home, school, and neighbourhood peer group; for an adult, among family, work, and social life)" (Bronfenfrenner, 1979, p.25), which are the teachers', peers', and neighbourhood's interactions with the individual as well as with each other. This structure foments a basic network of relationships for the individual. Each relationship is more likely to support development when there are links between home and childcare, in the form of visits and cooperative exchanges of information. (Berk, 2013).

Third, the ***exosystem***, "refers to one or more settings that do not involve the developing person as an active participant, but in which events occur that affect, or are affected by, what happens in the setting containing the developing person" (Bronfenbrenner, 1979, p.25), reflected in entities such as the school's board or peers' family background.

Fourth, the macrosystem "refers to consistencies, in the form and content of lower-order systems (micro-, meso-, and exo-) that exist, or could exist, at the level of the subculture or the culture as a whole, along with any belief systems or ideology underlying such consistencies" (Bronfenbrenner, 1979, p.26), thus comprising "cultural values, laws, customs, and resources" (Berk, 2013, p.28).

The three previous sub-sections (2.2.2 to 2.2.4), based on diverse fields of economic science specified some of this systems and interactions and their influences on the individual, deconstructing the Bronfenbrenner's russian doll. The following empirical analysis on students' environmental awareness and attitudes, seeks to measure the above-

mentioned contextual effects (parents and family, school and teaching, and peers) together with individual characteristics using PISA 2015 data for Portugal.

3. EMPIRICAL ANALYSIS: DATA SOURCE AND EMPIRICAL STRATEGY

3.1 Data Source

In this chapter is given an overview of the methodology used to conduct this dissertation starting from a presentation of the main data source used, the Microdata of PISA 2015. A brief description of PISA carried out by the OECD in 2015 will be offered.

Bergbauer, Hanushek and Woessman (2018) further emphasize the importance of international comparison of performance for the improvement in student achievements. The authors conclude that these mechanisms increase accountability and are especially important in poor performing countries and schools but that the effect remain throughout the range of countries (Hanushek, 2018).

The number of publications using OECD's PISA and other established education databases, such as the Progress in International Reading Literacy Study (PIRLS) (Striethol & Scherer, 2018) in the USA, is sustainably growing. Policy papers and other forms of grey literature are increasingly directing efforts to educational challenges which must be followed by academic insights (Hopfenbeck et al., 2018).

3.1.1 Data source: PISA questionnaires.

The OECD's PISA survey aims to test the skills and knowledge of 15-year-old students, at the end of compulsory school, and "is the most comprehensive and rigorous international programme to assess student performance and to collect data on the student, family and institutional factors that can help to explain differences in performance" (OECD, 2016, p.10).

The content of the survey varies across time being its specificity cyclically changed every three years between reading, science and mathematics. Besides the cognitive tests, PISA collects information through context questionnaires that provide a much-needed insight from agents of change "measuring student's engagement at school, dispositions towards school and their self-beliefs, and in gathering information about students'

backgrounds and the learning environment at school" (OECD, 2016, p.101). PISA 2015, in this research, is focused on science updating the information gathered from PISA 2006[8].

These context questionnaires are given to students and school principals, both mandatory; two questionnaires are given to students' parents and teachers with optional completion; and two other questionnaires are offered, a computer familiarity questionnaire and an educational career questionnaire, both to be answered by the students (Fontainha, 2014; OECD, 2016; IAVE[9], 2018; OECD, 2018).

In the present research, and contrary to one of the main lines of research using PISA data, the student results of cognitive assessment tests are not integrated into the analysis. Based on the main research question, the focus lies on the explanation of the awareness and attitudes of students concerning environmental issues, stressing the parents' role. The specific microdata base built under this research project is composed by the information collected in Portugal in 2015 by four context questionnaires made to students, parents, school principals, and teachers. These four questionnaires gather information about:

- Students questionnaire, on "students and their family backgrounds, including their economic, social and cultural capital; aspects of students' lives, such as their attitudes towards learning, their habits and life in and outside of school, and their family environment; and aspects of learning, including students' interest, motivation and engagement" (OECD, 2016, p.15);
- Parent questionnaire, "focusing on parents' perceptions of and involvement in their child's school, their support for learning at home, school choice, their child's career expectations, and their background (immigrant/non-immigrant)" (OECD, 2016, p.15);
- School Principal questionnaire, focusing on "aspects of schools, such as the quality of the schools' human and material resources, public and private management and funding, decision-making processes, staffing practices and

[8] In PISA 2015, four minor areas were assessed: Reading, Mathematics, Collaborative Problem Solving and Financial Literacy.

[9] Retrieved from: http://www.iave.pt/index.php/estudos-internacionais/pisa/apresentacao?showall=1&limitstart=

the school's curricular emphasis and extracurricular activities offered; and the context of instruction, including institutional structures and types, class size, classroom and school climate, and reading activities in class" (OECD, 2016, p.15);

- Teacher questionnaire, that helps to "illustrate the similarities and differences between groups of teachers in order to better establish the context for students' test results. (…) Science teachers are asked to describe their teaching practices through a parallel questionnaire that also focuses on teacher-directed teaching and learning activities in science lessons, and a selected set of inquiry-based activities. The teacher questionnaire asks about the content of a school's science curriculum and how it is communicated to parents" and "gathers information on transformational leadership" (OECD, 2016, p.15).

3.1.2 Main Database Construction.

The construction of the database used for this research was made using IBM SPSS and the choice of questions based on the extensive academic literature researched (Bergbauer et al., 2018; Coertjens et al., 2010; de Lange et al., 2014; Duarte et al., 2017; Hampden-Thompson, 2009; Hampden-Thompson et al., 2013; Hanushek & Woessmann, 2007; Perera, 2014; Bybee & McCrae, 2011; Hopfenbeck et al., 2018; Xu & Hampden-Thompson, 2012). There were initially three datasets present: Student and Parent; School; and Teacher.

The construction was made according to the following criteria:

1. The three data-sets were filtered to Portuguese data and to the questions chosen;
2. All the missing values were turned into system-missing for simplicity purposes;
3. The FAMeduMOT and FAMeduFAT dummy variables, which count for the educational level of the parents, do not comprehend post-secondary education due to problems in the microdata;

4. All the teacher variables account for the school's median teacher, this was made due to the impossibility to link teachers and students, being only possible the association with the correponding school;
5. When there was full-time/part-time distinction, only full-time teachers were considered (SCH_tea_n, SCH_tea_prof_per, SCH_tea_5anos_per, SCH_tea_5mais_per);
6. The TCsciEMP variable comes from a question that was only asked to science teachers.

These variables are labelled according to OECD (2017) scaling procedures for most part, or generic keywords for the ones which the first procedure wasn't possible, and built using IBM SPSS to manipulate the original data, as presented in Appendix A.

The three different datasets are combined in a single file where the unit of observation is the student. This merge was made through the School ID presented in the three datasets. Proceeding to a two-step matching process: first, due to the above mentioned in the criteria, the teachers were matched to the respective school through the median answers. In this sense, was arranged a file (SCH/TC) in which the observation unit was the school with the teachers' characteristics associated. Second, this file was matched with the Student and Parent file providing, therefore, a database where the observation unit is the student with the student, parent, school, and teacher characteristics associated.

This new file is composed by 7325 students and corresponding fathers and/or mothers, 246 schools and the corresponding median teachers. The total of original variables is 57[10].

[10] Complete list of variables in Table B1.

Table 1. Variable Descriptions

Variables	Description
Student Awareness (*STawaE*)	Level of information perceived (exact match). (Sum index) Q=5 MIN=5 MAX=20
Student Attitudes (*STattE*)	Level of Pessimism perceived (exact match). (Sum index) Q=5 MIN=5 MAX=15
Student Gender (*STmale*)	=1 if the respondent is a man, 0 if is a woman.
Student Science Enjoyment (*STsciJoy*)	Level of enjoyment learning science perceived. (Sum index) Q=5 MIN=5 MAX=20
Student Future Goal (*STeduGoalsD*)	=1 if the student expects to complete ISCED level 5 or 6, =0 if ISCED level 4 or inferior.
Student Interest in Science Career (*STsciCareer*)	Level of Instrumental Motivation perceived. (Sum index) Q=4 MIN=4 MAX=16
Student Perception Parental Support (*PARSUP_ST*)	Level of Parental Support perceived by the student during this academic year. (Sum index) Q=4 MIN=4 MAX=16
Parent Perception Parental Support (*PARSUP_PAR*)	Level of Parental Support perceived by the parent during the last academic year. (Sum index) Q=4 MIN=4 MAX=16
Parent-Student Interaction (*PAR_ST_int*)	Level of parent-child interaction perceived by the parent. (Sum index) Q=8 MIN=11 MAX=40
Parent Awareness (*PARawaE*)	Level of concern perceived by the parent (exact match). (Sum index) Q=5 MIN=5 MAX=20
Parent Attitudes (*PARattE*)	Level of Pessimism perceived by the Parent (exact match). (Sum index) Q=5 MIN=5 MAX=15
Answering Parent Gender (*PARmale*)	=1 if the questionnaire was answered by the father or male equivalent, =0 if the questionnaire was answered by the mother or female equivalent.
Stimuli to Science when 10years (*PAR_10yo*)	Level of stimuli given at age 10. (Sum index) Q=10 MIN=10 MAX=39
Parental Expectations Science Career (*PARsciCareer*)	Parental view on Child's Science Career. Sum of five dummy variables for different instrumental motivations perceived by the parent. Each on =1 if "Yes, =0 if otherwise.
Parental Science Relevance (*PARsciRel*)	Level of science relevance perceived by the parent. (Sum index) Q=5 MIN=5 MAX=20
Parental School Engagement (*SCHeng_PAR*)	Parental School Engagement Index. Sum of ten dummy variables for different school engagement participations during the last academic year by the parent. Each on =1 if present, =0 if otherwise.
Mother's Educational Level (*FAMeduMOT1*)	=1 if the mother did not complete ISCED 1, =0 if otherwise.
Father's Educational Level (*FAMeduFAT1*)	=1 if the father did not complete ISCED 1, =0 if otherwise.
Household Annual Income (*FAMincD*)	=1 if the household annual income is below €7500, =0 if €7500 or more.
Household Cultural Resources (*FAMcultRes*)	Sum of five dummy variables for different cultural resources present in the household. Each on =1 if present, =0 if otherwise.
Household No. of Books (*FAMbooksD*)	=1 if there are 25 books or more in the household, =0 if 0-24 books in the household.
Peer Integration (*PEERint*)	Level of integration with peers perceived. (Sum index) Q=6 MIN=6 MAX=24

Note: See Appendix A for details on variables' construction.

(Q = nº of questions summed to compute the index)

The endogenous variables STawaE and STattE represent the sum of the scores to 5 questions each, and account only for the questions that were asked to parents and students about precisely the same matter.

For STawaE the questions were: (i) "How informed are you about this environmental issue? Nuclear waste", (ii) "/The consequences of clearing forests\other land use", (iii) "/Air pollution", (iv) "/Extinction of plants and animals", (v) "/Water shortage". The answers to each question were scaled in: (i) "I have never heard of this", (ii) "I have heard about this but I would not be able to explain what it is really about", (iii) "I know something about this and could explain the general issue", (iv) "I am familiar with this and I would be able to explain this well".

For STattE the questions were: (i) "This issue will improve or get worse over next 20 years? Air pollution", (ii) "/Extinction of plants and animals", (iii) "/Clearing of forests for other land use", (iv) "/Water shortage", (v) "/Nuclear waste". The answers to each question were scaled in: (i) "Improve", (ii) "Stay about the same", (iii) "Get worse".

For description purposes the sampled students were all born in 1999, aged (using a continuous variable) between 15.33 and 16.33 ($\mu = 15.7811$, $\sigma = .28445$) and had a near-perfect gender division (49.8% females and 50.2% males). As for the parent that completed the questionnaire, question answered by 6194 (84.6%) parents, mothers, 84.3%, are the vast majority against 15.7% of fathers.

As for socioeconomic characteristics, from the 6059 (82.7%) student parents that answered this question the majority, 56.7%, have an annual income of less than €11249. As for expenses with educational providers, from the 6654 (90.8%) answers, 74.8% affirmed to have made expenses within the last twelve months.

For school characteristics, among the sample of 7235 (98.8%) students that belong to schools that provided this information, 6897 (95.3%) belong to public schools and 338 (4.7%) to private schools; as for the type of the schools' community, within the 7235 (90%) students that belong to schools that answered this question, 60.4% go to school in a community with 15000 people or more. Moreover, as for the average class size, 6019 (82.2%) students belong to schools that answered this question, among which 51% are in class with 25 students or more.

As for the 4228 teachers surveyed[11], the gender question was answered by 3689 (87.3%), among which, 2664 (72.2%) were females and 1025 (27.8%) were males; the type of contract employment was answered by 3688 (87.2%) teachers, where 634 (17.2%) had a fixed-term employment contract and 3054 (82.8%) had a permanent employment.

3.2 Empirical Strategy

In order to proceed to the statistical analysis of the microdata IBM SPSS version 24 was used to develop the basic analyses (e.g. descriptive, correlation). The same software was used to manage, filter and combine the original datasets of PISA database. The two large groups of regressions concerning consciousness or knowledge of environmental problems (the awareness *STawa* models) and the optimism/pessimism perspectives for the future about environmental issues (the attitude *STatt* models) were generated and evaluated using STATA version 14 software in order to increase clarity and additional information. These Ordinary Least Squares (OLS) specification regressions are made according to the general model of:

$$STawaE_i = \alpha_{.} + \beta_{.}ST_i + \gamma_{.}PAR_i + \delta_{.}FAM_i + \lambda_{.}SCH_i + \psi_{.}TC_i + \theta_{.}PEER_i + u_i$$

$$STattE_i = \alpha_{.} + \beta_{.}ST_i + \gamma_{.}PAR_i + \delta_{.}FAM_i + \lambda_{.}SCH_i + \psi_{.}TC_i + \theta_{.}PEER_i + u_i$$

Where:

$Y_i =$ Dependent variables (*STawaE* and *STattE*);

$ST_i =$ Vector of variables related to student;

$PAR_i =$ Vector of variables related to parent;

$FAM_i =$ Vector of variables related to family background;

$PEER_i =$ Vector of peer integration variable;

$SCH_i =$ Vector of variables related to school;

$TC_i =$ Vector of variables related to teacher.

[11] This description was calculated based on the original dataset for teachers in order to maintain interpretative meaning.

The abovementioned correlations[12] were made to three sets of variables in the student and parent questionnaires using *exactly the same questions* present in both surveys. The first, concerns the level of environmental issues awareness measured by an index based on five questions. The second about the environmental-related attitudes, also measured by an index based on five questions. The third, deals with information about the levels of parental support collected by the student questionnaire (the support the student perceives, *PARSUP_ST*) and the parent questionnaire (the support the surveyed parent reports, *PARSUP_PAR*). All these correlations are also sub divided by parent (mother and father) that fulfilled the questionnaire (*PARmale*) and by the students' gender (*STmale*).

Posteriorly, linear regressions were conducted to test the following hypotheses:

H1: Parents and family have a major role in the students' awareness towards environmental matters.

H2: Parents and family have a major role in the students' attitudes towards environmental matters.

These hypotheses were assessed for the entire sample and subsequently within subgroups of the variables respecting to the students' gender (*STmale*). Further specifications were conducted in order to estimate two models for the parents.

4. RESULTS AND DISCUSSION

The correlation results matrix (Appendix D) gives this dissertation a preliminary insight on the similarities between students and parents, providing for information on the awareness and attitudes index, as well as on the individual characteristics.

Analysing the correlation between student awareness index (*STawaE*) and parent (*PARawaE*), that is positive as expected, it has a significant value with $\alpha = .01$. The air pollution has the highest coefficient value and the lowest is nuclear waste. When the association is analysed in separate by fathers and mothers, there is a much higher mothers correlation than it is with the fathers, although the sample (for each parent) disparities possibly influence these factors. Father's coefficients are not statistically significant making impossible further explanations. The only father coefficient significant at $\alpha = .05$

[12] Correlation matrixes presented in Appendix D.

concerns clearing of forests. The mother's highest is air pollution. The distinctions between the students' gender, shed light on the higher correlations on specific questions. The awareness variable has a higher correlation for females than for males, as do nuclear waste, air pollution and water shortages. For males, the higher correlations concern clearing of forests and extinction of plants and animals. Male students have no correlation with their parents in what concerns water shortage. An interesting gendered phenomenon arises, the highest coefficient when the division was made to fathers/mothers and when it was made for male/female students, respectively, gave the exact same highest correlations, with the feminine side being more correlated in air pollution and the masculine one in the clearing of forests.

For attitudes, the coefficients between parents and students are much higher than for awareness, corroborating the literature (Coertjens et al., 2010). From the specific questions, the highest values are for water shortage and the lowest for the clearing of forests. When the division by parent gender is made, the mothers' correlations are *always* higher the fathers' being the highest differences in coefficients concerning the indexed variable and the water shortage question. As to the students' gender division, the same issue arises**,** *the correlations are always higher for females than for males*. The highest score for fathers is the same as for male students, as it happened in the awareness variable, in the water shortage question, but for the female gender this inference does not hold. The coefficients of the indexed variables are the highest for the five cases.

In what concerns parental support perceived by the parent and the student it is associated to support when facing difficulties (r = .253). The mothers' support correlations are always higher than the fathers' ones. With both correlating with their child perception of the support. The fathers' lowest significant coefficient is the support in educational efforts and achievements (r = .174) while the mothers' is the interest in school activities. As for the student gender division, the female students correlate **always** higher with the parents than the male does. The fact that the highest correlations are, for all the four scenarios, the same (support when facing difficulties) provides an inference that parents and students *correlate the highest* when the student is in difficulties, however the *lowest being parental interest in school activities* suggests that on the daily basis, both have quite different perceptions.

Table 2. Students' Awareness Regression Results. All students and by Gender
Dependent Variable: *Awareness of Environmental Issues Index (STawaE)*
(see Table 1 for details about each variable)

VARIABLES	All	Male Students	Female Students
Constant	8.554***	8.406***	8.548***
	(.646)	(.960)	(.869)
Student Science Enjoyment	.249***	.301***	.195***
(*STsciJoy*)	(.012)	(.018)	(.017)
Student Future Goal	1.002***	.747***	1.260***
(*STeduGoalsD*)	(.093)	(.140)	(.128)
Student perception Parental Support	.094***	.064**	.116***
(*PARSUP_ST*)	(.021)	(.032)	(.028)
Stimuli to Sciences when 10years	.046***	.043***	.056***
(*PAR_10yo*)	(.010)	(.014)	(.014)
Parent-Student Interaction	-.037***	-.048***	-.026**
(*PAR_ST_int*)	(.008)	(.012)	(.011)
Parental expectations science career	.118***	.108***	.140***
(*PARsciCareer*)	(.023)	(.035)	(.031)
Parental Awareness	.054*	.067	.043
(*PARawaE*)	(.028)	(.041)	(.038)
Household Cultural Resources	.144***	.127***	.153***
(*FAMcultRes*)	(.029)	(.043)	(.041)
Mother's Educational. Level	-.188	-.336	-.015
(*FAMeduMOT1*)	(.133)	(.204)	(.174)
Household Annual Income	-.374***	-.680***	-.087
(*FAMincD*)	(.090)	(.136)	(.119)
Household No. of Books	.194**	.105	.318**
(*FAMbooksD*)	(.095)	(.140)	(.127)
Peer integration	.037***	.052***	.023
(*PEERint*)	(.012)	(.017)	(.016)
No. of Obs.	4,642	2,239	2,403
Prob > F	.000	.000	.000
R^2	.237	.246	.242
Adj. R^2	.235	.242	.238

Note. Standard errors in parentheses *** p<0.001, ** p<0.01, * p<0.05
Source: Own computations

The awareness regression analysis, presented in Table 2, provides several claims. The fact that the *science enjoyment*, as a non-cognitive skill, has significance and reinforces Grönqvist and colleagues (2017), Hampel and colleagues (1996) and Lundberg (2017) claims, being observable in both genders but with a higher coefficient on the male part. Strathman and colleagues (1994) and Webley and Nyhus (2006) conclusions on future orientation are also reinforced, being that the *students' expected educational attainments* and the *parental expectations for the child's science career* show significance, with higher coefficients for female students. This is furtherly remarked by Haveman and Wolfe (1995) statements on the importance of the expectational environment, as it is on the significance of the stimuli provided by parents at earlier ages.

On what concerns the importance of *cultural resources* and *books* in the household, the coefficients turned out significant, corroborating Perera (2014) and Xu and Hampden-Thompson (2012), but with an increased weight on the feminine side, being that the books in the household variable loses significance for male students.

Duarte and colleagues (2017) and Xu and Hampden-Thompson (2012) argue for the importance of socioeconomical variables, which is also reinforced in these results with statistical significance, therefore inferring that households with low annual *incomes* do tend to influence negatively the awareness of students. However, Pe'er and colleagues (2007) conclusion on the stronger effect fathers have in the income indicators are somewhat confirmed, being that, in fact, for male students the socioeconomic variable turns out significant and with a high coefficient but loses significance for female subjects.

Furthermore, Coertjens and colleagues' (2010) arguments for the lessened importance of the parents' awareness to the explained variance of the student are corroborated, as the parental awareness variable only shows partial significance for the entire population and male students, losing significance for female subjects.

As for how *parental support is perceived by the parent*, the variable has significance with positive effect in all the cases as referred in the literature (Hampden-Thompson et al., 2013; Hampel et al., 1996). However, Hampden-Thompson and colleagues' (2013) argument on the possible negative *relationship between parent-student interaction* and awareness due to poor school performance come out reinforced, showing negative coefficients in all cases.

Peer integration effects also show significance on student awareness, corroborating Manski (1993) on the importance of peer interactions and classmates in the achievements of students. However, for female students, peer integration does not show significance. On light of the preliminary exploration of the data, this may be due to male students' higher competitiveness within classes.

A disappointing outcome comes from the *educational levels of parents*, specially mother's, which are subject to extensive literature on the effect on student's awareness and knowledge (Becker, 1991; Duarte et al., 2017; Ermisch & Francesconi, 2001; Hampel et al., 1996; Heckman & Masterov, 2004; Hertz et al., 2007; Tabellini, 2008;). This is measured in our model by the dummy variable regarding the completion of primary

education by the mother, which does not show significance for the entire sample as well as for female students, showing only partial significance for male subjects, but still reinforcing Leibowitz (1974) and Pe'er and colleagues' (2007) claims that mother's educational as a higher impact than the father's. From the exclusion of the student gender variable comes another unexpected result, being the gender matter extensively stated in the literature (Duarte et al., 2017; Sacerdote, 2011).

In what concerns the pessimistic attitudes, measured in Table 3, the student's educational expectations contribute positively, especially for females as argued by Duarte and colleagues' (2017), and do not show significance for males. The parents' attitudes are, as expected, significant, being higher for females than males, in accordance with the previous correlation analysis and the literature on the matter (Coertjens et al., 2010; Eagle et al., 2015; Grønhøj & Thøgersen, 2012; Kelly, 2006). Having more than 25 books in the household shows significance (Hampden-Thompson et al., 2013; Hampel et al., 1996) and contributes to pessimistic attitudes.

As for the variables that affect negatively the pessimistic attitudes, the *parental school engagement* has an effect on male students not showing significance for females (Hampden-Thompson et al., 2013; Hampel et al., 1996). The *science career interest* does too, corroborating the literature (Strathman et al., 1994; Webley & Nyhus, 2006). The annual *income* has significance (Duarte et al., 2017; Xu & Hampden-Thompson, 2012), as it did in the awareness, and shows a negative relationship with the pessimism, which means that as income increases so does the pessimistic attitude.

The *gender* variable, contrarily to the awareness, shows significance in the attitudinal component, corroborating Coertjens and colleagues (2010) and Duarte and colleagues (2017) statements on female students having more environmental attitudes than male, in this case they are more pessimistic probably because of the differences concerning risk aversion. Female students are less positive by .38 than male. Parental awareness did not show significance in the subgroups, contradicting Perera (2014), showing only partial significance of an optimistic effect for the entire sample.

The *peer* effect was excluded for not showing signs of explanatory significance contradicting, therefore, the literature stating that attitudes are more influenced by peer effects than the awareness component (Sacerdote, 2011).

Table 3. Students' Attitudes Regression Results. All students and by Gender
Dependent Variable: *Environmental Attitudes Index (STattE)*

(see Table 1 for details about each variable)

VARIABLES	Entire Sample	Male Students	Female Students
Constant	7.686***	8.432***	6.232***
	(.731)	(1.051)	(1.001)
Student Future Goal	.537***	.231	.902***
(STeduGoalsD)	(.111)	(.162)	(.149)
Student interest in science career	-.081***	-.117***	-.050***
(STsciCareer)	(.014)	(.023)	(.018)
Student Gender	-.380***	-	-
(STmale)	(.099)	-	-
Parental Attitudes	.338***	.293***	.382***
(PARattE)	(.016)	(.023)	(.021)
Parental Awareness	.051	.069	.044
(PARawaE)	(.036)	(.052)	(.049)
Parental School Engagement.	-.069**	-.103***	-.034
(SCHeng_PAR)	(.022)	(.033)	(.029)
Household No. of Books	.469***	.323**	.657***
(FAMbooksD)	(.108)	(.162)	(.142)
Household Annual Income	-.369***	-.697***	-.017
(FAMincD)	(.110)	(.164)	(.145)
No. of Observations.	4,138	2,126	2,012
F-value	.000	.000	.000
R2	.155	.121	.203
Adjusted R2	.154	.118	.200

Standard errors in parentheses *** p<0.001, ** p<0.01, * p<0.05.

Source: Own computations

Table 4. Parental Predictors in Students' Awareness Regression Results. By Answering Parent Gender
Dependent Variable: *Environmental Awareness Index (STawaE)*
(Table 1 for details about each variable)

VARIABLES	Father	Mother
Constant	9.349***	9.735***
	(1.546)	(.755)
Student Gender	-.004	-.207**
(STmale)	(.215)	(.091)
Parent Perception Parental Support	.195***	.129***
(PARSUP_PAR)	(.072)	(.033)
Stimuli to Sciences when 10years	.094***	.093***
(PAR_10yo)	(.026)	(.011)
Parent-Student Interaction	.006	-.043***
(PAR_ST_int)	(.023)	(.010)
Parental Expectations Science Career	.257***	.339***
(PARsciCareer)	(.058)	(.025)
Parent Awareness	-.002	.085**
(PARawaE)	(.059)	(.033)
Parental Science Relevance	.102*	.103***
(PARsciRel)	(.053)	(.023)
Father/Mother Educ. Level	-1.440***	-.408***
(FAMeduFAT1/FAMeduMOT1)	(.413)	(.152)
No. of Observations.	827	4,231
Probability F	.000	.000
R2	.123	.111
Adjusted R2	.114	.109

Standard errors in parentheses *** p<0.001, ** p<0.01, * p<0.05.

Source: Own computations

The effect parental variables have on the awareness of the student differs when splitting fathers and mothers that answered the questionnaire, as presented in Table 4.

In what concerns the parental support perceived by the parent, the *stimuli gave at 10-years-old and the parental expectations for the student's science career* have statistical significance showing a positive effect on the students' awareness. A *low level of education* shows also a negative relationship with the student's awareness, meaning that the completion of ISCED 1 or higher has a positive effect on the awareness.

As for the variables that show differences in the direction of the effect, the *mother-student interaction* has a negative effect on the student's awareness, result that is unexpected. This may be due to Hampden-Thompson (2013) argument on the monitoring due to poor school-performance by the mother. In the Portuguese case about 40% of the

parents in this sample have a level of education lower than the level of education of their child. The variable related to *parents' awareness* also shows a significant positive effect by the mother and a negative non-significant effect on the father's side. This is reinforced by Leibowitz (1974) that, due to more interaction, mothers' educational attainments have a larger influence on children than fathers' education. The *relevance given to science by the parent* shows a positive effect on both parents, showing only partial significance on the father. In accordance, Perera (2014) states that parental interest in science influences the students in a significant manner. As for *the student gender*, on both cases the female students appear to have a bigger awareness of environmental-related topics, despite only showing significance and a bigger effect when the questionnaire was answered by the mother.

Table 5. Parental Predictors in Students' Attitudes Regression Results.
By Answering Parent Gender
Dependent Variable: *Environmental Attitudes Index (STattE)*
(Table 1 for details about each variable)

VARIABLES	Father	Mother
Constant	5.209***	5.910***
	(1.339)	(.602)
Student Gender	-.593***	-.661***
(STmale)	(.225)	(.098)
Parent Perception Parental Support	.156**	.066*
(PARSUP_PAR)	(.076)	(.035)
Stimuli to Sciences when 10years	.036	.038***
(PAR_10yo)	(.027)	(.012)
Parent-Student Interaction	-.061**	-.053***
(PAR_ST_int)	(.024)	(.010)
Parental Expectations Science Career	-.065	.081***
(PARsciCareer)	(.061)	(.027)
Parent Attitudes	.352***	.412***
(PARattE)	(.037)	(.015)
Parental Science Relevance	.085	.042*
(PARsciRel)	(.056)	(.024)
Father/Mother Educ. Level	-.608	.033
(FAMeduFAT1/FAMeduMOT1)	(.436)	(.163)
No. of Observations.	824	4,226
Probability F	.000	.000
R2	.131	.170
Adjusted R2	.122	.169

Standard errors in parentheses *** p<0.001, ** p<0.01, * p<0.05.

Source: Own computations

As expected, the gender shows high significance, having a much larger effect on the attitudes' component than the awareness component Coertjens and colleagues (2010) and Duarte and colleagues (2017). Parent attitudes, regardless of the parent have high significance and a higher effect on questionnaires fulfilled by the mother, in line with the previous correlation analysis findings. As for the importance of the expectational and future orientation environments stated by Haveman and Wolfe (1995), Webley and Nyhus (2006) and Strathman and colleagues (1994) appear to be according to these results in what concerns the mother questionnaires.

A surprising outcome seems to be the lack of significance of the parents' formal education on the attitudes of students, which may be due to the lack of relationship between the formation of attitudes and the knowledge component, or the percentage of low level of education of a large share of parents.

5. CONCLUSIONS

This dissertation sought to comprehend in what way and with how much strength the Portuguese parents play a role in their youngster's awareness and attitudes on a sustainable future, from its environmentalist perspective. The influence of family characteristics, school, teachers and peers were also tested.

A first conclusion suggests that parents, adopting Bisin and Verdier (2000, 2001a, b) intergenerational transmission of preferences theory, appear to be more perfectly empathic in the awareness and more imperfectly empathic on the attitudes. This finding is suggested by the correlations and in general by the estimated models.

Second, our results showed a much higher effect brought on by student, parent and family characteristics than it did for the variables concerning schools, peers or teachers. This may be due to an overlap between student variables and school and teacher-related variables. The expected results were that a more constructivist methodology of teaching would have a large impact on students' perceptions, however this was not confirmed. This conclusion goes in with the importance given by Haveman and Wolfe (1995) to the "*parental choices*" and the "*self-choices*".

Third, and continuing the reasoning, international organisations concerns on the importance of families within the 2030 agenda for Sustainable Development and in

particular in the SDG4 - Quality Education - appear to be, in fact, benchmarking and truthful.

Forth, this research corroborates the importance of parents and families in the improvement of non-cognitive skills (Carneiro & Heckman, 2003).

Fifth, the cultural resources and books in the household plays a part, especially concerning female students. For male students, the household income and other materialistic resources appears to have a higher importance in both awareness and attitudes.

Sixth, the study by student gender showed bigger effects in the attitudes than it did on the awareness with girls, corroborating Duarte and colleagues (2017).

Seventh, the parents' educational attainments only showed significance as a parental predictor for students' awareness. Despite extensive literary evidence about educational level of parental influence on students (in particular on students' performance), requiring further research for consistent inferences.

Eight, student's enjoyment of learning science and a higher expected future educational level were the most common student characteristics that affects positively environmental awareness and attitudes.

Ninth, peer effects are stressed in the literature as having impact on adolescent attitudes and behaviours and are frequently studied in context of delinquency practices. However, in this study, peers only showed relevance in the awareness component contradicting the majority of the literature on the matter, which poses their biggest effect on the attitudes.

Tenth, as expected from the literature analysis about the parent-children relation by gender the results showed that girls correlate heavier with their parents than boys and mothers correlate heavier with their children than fathers.

Eleventh, specific environmental issues seem to have a gendered prioritization of awareness and concerns, showing that males (students or fathers) prioritize the clearing of forests while females have more concerns on air pollution.

Twelfth, according to the literature students are affected quite a lot by the school characteristics, however, these effects are not evident in this study. The way the variables

about school and teaching were measured, because, contrary to parents there was no information about the specific teacher of the student probably contributes for the weakness of the results. As previously referred, there may be hidden school and teaching methodology effects within the student variables.

Thirteenth, the PISA questionnaires, including similar questions to students and the respective mother or father, provided a unique opportunity to study the intergenerational transmission of preferences. From PISA data is also possible to contrast the student and father/mother' perceptions, for example, about the support received (or given) to the studies. Furthermore, the parental support correlation analysis showed that parents and children have similar perceptions on structural support, showing higher coefficients when facing difficulties or unexpected situations than they do concerning the daily basis activities.

Fourteenth, Pisa data provides a very rich information concerning the contextual variables of the student and this shed light on the causes for the development of the cognitive and non-cognitive skills.

This study of the Portuguese case also conclude that Sustainable Development Goals Agenda must work to and with families in order to strive. The importance of families to awareness and attitudes towards a brighter future is undeniable and the presence of nurturing, comprehensive and caregiving parents associated with a stimulating household appears to invite students to dig deeper on the understanding of their role as agents of change in tomorrow's world.

Limitations and Future Research Avenues

The gap between ex-ante characteristics, such as awareness, knowledge and attitudes, and ex-post behaviours could not be explored due to unavailability of data concerning PISA, requiring future research deepening.

Another interesting research avenue, lifted along the research made for this thesis, concerns a likely not linear effect between parent's income and parental support on the young. From the research made, this happens because reaching a certain income, a crowding-out effect on the parental investment appears to happen towards market service acquisition for caregiving and educational support of the students.

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APPENDICES

Appendix A: Variable Manipulations

The manipulations required to build the new variables are according to the following different cases:

- In the case of a positive subscale, a simple sum of the answers' score to each question (*STawa/STawaE*, *STatt/STattE*, *PARatt/PARattE*, *PAR_ST_int*, *STsciJoy*, *PARSUP_ST*, *PARSUP_PAR*, *STamb*, *TCsciEMP*);
- In the case of a negative subscale, a symmetric recode was made followed by the sum of the scores (*PARawa/PARawaE*, *STanx*, S*TsciCareer*, *STsciApply*, *PAR_10yo*, *PARsciRel*);
- In the case of a subscale that had positive and negative questions, a symmetric recode to the negative questions was made in order to harmonize the answers, followed by the sum of the scores (*PEERint*, *TCsat*);
- In the case of a subscale composed by questions with a binary answer, and when the "No" = 2, a recode was made to (1 = 1) and (2 = 0) followed by the sum of the scores (*SCHeng_PAR*, *PARsciCareer*, *SCHres*[13], *SCHeng_SCH*, *TCprofDEV*);
- In the case of a dichotomous variable where "No" = 2, a recode was made to (1 = 1) and (2 = 0) (*SCHpublic*, *TCgoal*, *TCprofDevR*);
- In the case of categorial variables, a partition of the categories was made in order to create dummy variables with direct interpretation coefficients (*STeduGoalsD*, *FAMbooksD*, *FAMincD*, *FAMeducExpD*, *SCHcom*, *SCHclassSyzeD*)
- For the *STmale* variable, was made a recode to "Female" = 0 and "Male" = 1;
- For the *SCHqual* variable, a recode to 1 = 0, 3 = 0 and 2 = 1 was made in order to group the answers where there wasn't a self-evaluation score of "satisfactory";
- For the *TCcontract* variable, a recode was made to 1 = 1, 2 = 0 and 3 = 0 in order to group teachers with permanent employment and fixed-term employment;
- For the *SCHprofDev* and *SCH_tea_n* variables, as it represents an absolute frequency and a percentage of teachers who attended professional development activities, respectively, no manipulation was made;
- For the *TCmethodStandardD_SCH* and *TCmethodTeacherD_SCH* variables, which come from a subscale with 4 questions and a 5-levels' answers, the treatment was as follows:
    - To each of the 4 questions: 1-to-3 = 0 and 4-and-5 = 1 which means less than once a month and once or more a month, respectively;

[13] *SCHres_11*, because it was a country specific item, had a particular recode: (0620001 = 1 and 0620002 = 0) to be harmonized with the rest.

  - A sum of the scores of, *SC34_1* and *SC34_2*, and, *SC34_3* and *SC34_4*, each one representing the most common methodology, followed by a recode of 2 = 1 to prevent for double "yes";
  - This manipulation represents, therefore, two dummy variable accounting for the core evaluation methodology applied in the school. If the school has a positive answer in one variable, it means that it applies the respective methodology at least once a month.

- For the *FAMseRes*, *FAMeducRes*, *FAMcultRes* variables, which come from the sum of binary answers present in subscales ST11 (13 items) and ST12 (8 items), the treatment was as follows:
  - Excluded ST12_1 and ST12_6 because they were repeated in ST11_17, in this case partially, and ST11_4, respectively;
  - Regrouped the items according to OECD (2017, p.300) in socioeconomic, educational and cultural items;
  - Recoded the ST11 questions to 1 = 1 and 2 = 0[14];
  - Recode the ST12 questions to 1 = 0 and 2-4 = 1;
  - Each variable represents, therefore, the level of a respective type of resources present in the student's family environment.
- For the *PARmale* variable, which comes from 3 dummies asking if the questionnaire was answered by the mother, father, or other, the manipulation was made in order to create mutual exclusivity between mother and father, assuming that questionnaires that were fulfilled by both or by others as system-missing, retaining still 92.9% of the answers present;
- For the *FAMeduMOT* and *FAMeduFAT* dummies, which come from 2 categorial variables each with 5 categories, a dummy for each category was computed in order to isolate ISCED[15] levels effect;
- For the *SCH_tea_prof_per*, which come from an absolute frequency variable, a division by *SCH_tea_n* and multiplication by 100 in order to compute a percentage.

Appendix B: Variables

Table B1.

Variable Descriptions

Variables	Description
STawaE	Level of information perceived (exact match). (Sum index) Q=5 MIN=5 MAX=20
STattE	Level of Pessimism perceived (exact match). (Sum index) Q=5 MIN=5 MAX=15
STawa	Level of information perceived (general). (Sum index) Q=7 MIN=7 MAX=28

[14] ST11_17, ST11_18 and ST11_19 because they were country specific items, had a particular recode: (0620001 = 1 and 0620002 = 0) to be harmonized with the rest.

[15] International Standard Classification of Education see more in Appendix C

STatt	Level of Pessimism perceived (general). (Sum index) Q=7 MIN=7 MAX=21
STmale	=1 if the respondent is a man, 0 if is a woman.
STsciApply	Level of Self-efficacy in science phenomena perceived. (Sum index) Q=8 MIN=8 MAX=32
STsciJoy	Level of enjoyment learning science perceived. (Sum index) Q=5 MIN=5 MAX=20
STeduGoalsD	=1 if the student expects to complete ISCED level 5 or 6, =0 if ISCED level 4 or inferior.
STsciCareer	Level of Instrumental Motivation perceived. (Sum index) Q=4 MIN=4 MAX=16
STanx	Level of tranquillity perceived by the student. (Sum index) Q=5 MIN=5 MAX=20
STamb	Level of ambition perceived by the student. (Sum index) Q=5 MIN=5 MAX=20
PARSUP_ST	Level of Parental Support perceived by the student during this academic year. (Sum index) Q=4 MIN=4 MAX=16
PARSUP_PAR	Level of Parental Support perceived by the parent during the last academic year. (Sum index) Q=4 MIN=4 MAX=16
PAR_ST_int	Level of parent-child interaction perceived by the parent. (Sum index) Q=8 MIN=11 MAX=40
PARawaE	Level of concern perceived by the parent (exact match). (Sum index) Q=5 MIN=5 MAX=20
PARattE	Level of Pessimism perceived by the Parent (exact match). (Sum index) Q=5 MIN=5 MAX=15
PARawa	Level of concern perceived by the parent (general). (Sum index) Q=7 MIN=7 MAX=28
PARatt	Level of Pessimism perceived by the parent (general). (Sum index) Q=7 MIN=7 MAX=21
PARmale	=1 if the questionnaire was answered by the father or male equivalent, =0 if the questionnaire was answered by the mother or female equivalent.
PARsciRel	Level of science relevance perceived by the parent. (Sum index) Q=5 MIN=5 MAX=20
PAR_10yo	Level of stimuli given at age 10. (Sum index) Q=10 MIN=10 MAX=39
PARsciCareer	Parental view on Child's Science Career. Sum of five dummy variables for different instrumental motivations perceived by the parent. Each on =1 if "Yes, =0 if otherwise.
SCHeng_PAR	Parental School Engagement Index. Sum of ten dummy variables for different school engagement participations during the last academic year by the parent. Each on =1 if present, =0 if otherwise.
FAMincD	=1 if the household annual income is below €7500, =0 if €7500 or more.
FAMeducExpD	=1 if the educational expenses in the last 12 months are above 0€, =0 if otherwise.
FAMcultRes	Sum of five dummy variables for different cultural resources present in the household. Each on =1 if present, =0 if otherwise.
FAMseRes	of six dummy variables for different socioeconomic resources present in the household. Each on =1 if present, =0 if otherwise.
FAMeducRes	Sum of eleven dummy variables for different educational resources present in the household. Each on =1 if present, =0 if otherwise.
FAMbooksD	=1 if there are 25 books or more in the household, =0 if 0-24 books in the household.
FAMeduMOT1	=1 if the mother did not complete ISCED 1, =0 if otherwise.
FAMeduMOT2	=1 if the mother's highest ISCED level is 1, =0 if otherwise.
FAMeduMOT3	=1 if the mother's highest ISCED level is 2, =0 if otherwise.
FAMeduMOT4	=1 if the mother's highest ISCED level is 3B/3C, =0 if otherwise.

FAMeduMOT5	=1 if the mother's highest ISCED level is 3A, =0 if otherwise.
FAMeduFAT1	=1 if the father did not complete ISCED 1, =0 if otherwise.
FAMeduFAT2	=1 if the father's highest ISCED level is 1, =0 if otherwise.
FAMeduFAT3	=1 if the father's highest ISCED level is 2, =0 if otherwise.
FAMeduFAT4	=1 if the father's highest ISCED level is 3B/3C, =0 if otherwise.
FAMeduFAT5	=1 if the father's highest ISCED level is 3A, =0 if otherwise.
SCHcomD	=1 if there are less than 15 000 people in the community, =0 if there are 15 000 people or more in the community.
SCHclassSyzeD	=1 if there are up to 25 students in the class, =0 if there are 25 students or more.
SCHpublic	=0 if the school is private, =1 if public.
SCH_tea_n	Number of teachers employed in the school in full-time.
SCH_tea_prof_per	Percentage of teachers fully certified by the appropriate authority in full-time.
SCHprofDev	Percentage of teaching staff that attended a programme of professional development in the last 3 months within all teaching staff.
TCmetStandardD_SCH	=1 if the evaluation is made using a standardized test once a month or more, =0 if less than once a month.
TCmetTeacherD_SCH	=1 if the evaluation is made using a standardized test once a month or more, =0 if less than once a month.
SCHqual	School Quality Index. Sum of eight dummy variables for different levels of school measures. Each one =1 if satisfactory, =0 if otherwise.
SCHres	Sum of eleven dummy variables for different school extra-curricular activities present during this academic year. Each one =1 if present, =0 if not present.
SCHeng_SCH	Sum of six dummy variables for different parental engagement strategies implemented by the school. Each on =1 if present, =0 if otherwise.
TCcontract	=1 if the teacher has a permanent employment contract, =0 if its fixed-term.
TCgoal	After completing ISCED 3 or below, was your goal to pursue a career in the teaching profession? =1 if "Yes", =0 if "No".
TCprofDev	Sum of six dummy variables for different professional development activities participated in the last 12 months. Each one =1 if "Yes", =0 if "No".
TCprofDevReq	Are you required to take part in professional development activities? =1 if required, =0 if not required.
TCsat	Level of job satisfaction perceived by the teacher. (Sum index) Q=8 MIN=20 MAX=30
TCsciEMP	Level of emphasis given to constructivist approach tasks in science classes. (Sum index) Q=8 MIN=21 MAX=32
PEERint	Level of integration with peers perceived. (Sum index) Q=6 MIN=6 MAX=24

Note. (Q = nº of questions summed to compute the index)

Table B2.

Variables' Descriptive Statistics

Variable Name	Description	Survey	Cronb. Alpha	Q	R	N	Missing	$\bar{x}$	σ	MIN	MAX
STawa	Awareness Index of Students (general)	ST	0.899	7	4	6852	473	21.93	4.29	7	28
STawaE	Awareness Index of Students (exact match)	ST	0.895	5	4	6908	417	16.08	3.141	5	20
STatt	Attitudes Index of Students (general)	ST	0.912	7	3	6814	511	16.35	4.583	7	21
STattE	Attitudes Index of Students (exact match)	ST	0.9	5	3	6948	377	11.86	3.414	5	15
STmale	Student Gender (ST004)	ST	dummy	1		7325	0	0.5	0.5	0	1
FAMeduMOT1	What is the <highest level of schooling> completed by your mother? (ST005)	ST	dummy	1		7115	210	0.1	0.306	0	1
FAMeduMOT2	What is the <highest level of schooling> completed by your mother? (ST005)	ST	dummy	1		7115	210	0.18	0.386	0	1
FAMeduMOT3	What is the <highest level of schooling> completed by your mother? (ST005)	ST	dummy	1		7115	210	0.29	0.456	0	1
FAMeduMOT4	What is the <highest level of schooling> completed by your mother? (ST005)	ST	dummy	1		7115	210	0.1	0.305	0	1
FAMeduMOT5	What is the <highest level of schooling> completed by your mother? (ST005)	ST	dummy	1		7115	210	0.32	0.465	0	1
FAMeduFAT1	What is the <highest level of schooling> completed by your father? (ST007)	ST	dummy	1		7005	320	0.13	0.339	0	1
FAMeduFAT2	What is the <highest level of schooling> completed by your father? (ST007)	ST	dummy	1		7005	320	0.24	0.428	0	1

FAMeduFAT3	What is the <highest level of schooling> completed by your father? (ST007)	ST	dummy	1	7005	320	0.29	0.454	0	1
FAMeduFAT4	What is the <highest level of schooling> completed by your father? (ST007)	ST	dummy	1	7005	320	0.1	0.297	0	1
FAMeduFAT5	What is the <highest level of schooling> completed by your father? (ST007)	ST	dummy	1	7005	320	0.24	0.426	0	1
FAMseRes	Family SocioEconomic Resources Index (ST011/012)	ST	dummy score	6	6832	493	4.8	0.908	0	6
FAMeducRes	Family Educational Resources Index (ST011/012)	ST	dummy score	11	6809	516	8.37	1.521	0	11
FAMcultRes	Family Cultural Resources Index (ST011/012)	ST	dummy score	5	7060	265	2.92	1.585	0	5
FAMbooksD	How many books are there in your home? (ST013)	ST	dummy	1 6	7202	123	0.57	0.495	0	1
PARSUP_ST	Parental Support (Students) (ST123)	ST	0.854	4 4	7163	162	14.27	2.036	4	16
STeduGoalsD	Which of the following do you expect to complete? (ST111)	ST	dummy	1 6	7170	155	0.56	0.497	0	1
STanx	Student Anxiety Index (ST118)	ST	0.823	5 4	7075	250	10.56	3.168	5	20
STamb	Student Ambition Index (ST119)	ST	0.786	5 4	7061	264	15.55	2.802	5	20
PEERint	Peer Integration Index (ST034)	ST	0.824	6 4	6982	343	18.66	3.451	6	24
STsciJoy	Science Enjoyment Index (ST094)	ST	0.929	5 4	6918	407	14.08	3.515	5	20
STsciCareer	Instrumental Motival - Science Career Motivation (ST113)	ST	0.957	4 4	6837	488	11.72	3.407	4	16
STsciApply	Science Self-Efficacy - Perceived Ability to Explain Phenomena (ST129)	ST	0.914	8 4	6711	614	22.85	5.324	8	32
PARmale	Who will complete this questionnaire? Mother or other female guardian (PA001)	PA	dummy	1	6194	1131	0.16	0.363	0	1

PAR_10yo	10-year-old Child Science Activities Index (PA002)	PA	0.776	10	4	6542	783	18.68	4.613	10	39
PAR_ST_int	Parent-Child Interaction Index (PA003)	PA	0.766	8	4	6628	697	28.01	5.423	11	40
PARSUP_PAR	Parental Support (Parents) (PA004)	PA	0.782	4	4	6836	489	14.9	1.488	4	16
SCHeng_PAR	Parental School Engagement Index (PA008)	PA	dummy score	10		5347	1978	4.91	2.264	0	10
PARsciCareer	Parental view on Child's Science Career (PA032)	PA	dummy score	5		6553	772	2.13	1.968	0	5
PARsciRel	Parents perceived Science Relevance Index (PA033)	PA	0.82	5	4	6721	604	16.83	2.187	5	20
FAMeducExpD	Educational Expenses Dummy (PA041)	PA	dummy	1	6	6654	671	0.75	0.434	0	1
FAMincD	What is your annual household income? (PA042)	PA	dummy	1	6	6059	1266	0.57	0.496	0	1
PARawa	Awareness Index of Parents (general)	PA	0.831	7	4	6699	626	27.19	2.034	7	28
PARawaE	Awareness Index of Parents (exact match)	PA	0.782	5	4	6717	608	19.46	1.453	5	20
PARatt	Attitudes Index of Parents (general)	PA	0.914	7	3	6661	664	17.51	4.293	7	21
PARattE	Attitudes Index of Parents (exact match)	PA	0.897	5	3	6691	634	12.67	3.159	5	15
SCHcomD	Which of the following definitions best describes the community in which your school is located? (SC001)	SC	dummy	1	5	7235	90	0.4	0.489	0	1
SCHclassSyzeD	What is the average size of <test language> classes in <national modal grade for 15-year-olds> in your school? (SC003)	SC	dummy	1	9	6019	1306	0.49	0.5	0	1
SCHpublic	School: Public or Private (SC013)	SC	dummy	1		7235	90	0.95	0.211	0	1
SCH_tea_n	Teachers in TOTAL: Full-time (SC018)	SC	absolute frequency			6853	472	144.11	69.257	0	342
SCH_tea_prof_per	Percentage of teachers <fully certified> by <the appropriate authority>: Full-time (SC018)	SC	percentage			6267	1058	94.1987	21.22739	0	100

SCHprofDev	Percentage of teaching staff that attended a programme of professional development in the last 3 months? All teaching staff (SC025)	SC	percentage		6357	968	33.0299	27.61504	0	100
TCmetStandardD_SCH	How often are students assessed with standardized tests? (SC034)	SC	dummy	1	6047	1278	0.04	0.192	0	1
TCmetTeacherD_SCH	How often are students assessed with teacher practices? (SC034)	SC	dummy	1	6030	1295	0.96	0.206	0	1
SCHqual	School Quality Index (SC040)	SC	dummy score	8	6852	473	1.36	2.006	0	8
SCHres	School creative extra-curricular activities Index (SC053)	SC	dummy score	11	5373	1952	5.77	2.246	0	11
SCHeng_SCH	Parental School Engagement Index (SC063)	SC	dummy score	6	7011	314	5.67	0.632	3	6
TCcontract	What is your employment status as a teacher at this school? (TC004)	TC	dummy	1	5873	1452	0.97	0.157	0	1
TCgoal	After completing <ISCED level 3 or below>. was your goal to pursue a career in the teaching profession? (TC013)	TC	dummy	1	5705	1620	0.93	0.259	0	1
TCprofDev	Professional Development Activities Index (TC020)	TC	dummy score	6	5059	2266	2.86	0.817	1	5
TCprofDevReq	Are you required to take part in professional development activities? (TC021)	TC	dummy	1	5645	1680	0.66	0.472	0	1
TCsat	Teacher job satisfaction Index (TC026)	TC	0.741	8 4	4465	2860	24.51	1.864	20	30
TCsciEMP	Scientific Emphasis on Science Classes Index (TC041)	TC	0.67	8 4	3695	3630	29.44	1.568	21	32

Appendix C: ISCED

"The International Standard Classification of Education (ISCED) belongs to the United Nations International Family of Economic and Social Classifications, which are applied in statistics world-wide with the purpose of assembling, compiling and analysing cross-nationally comparable data. ISCED is the reference classification for organizing educational programmes and related qualifications by education levels and fields. ISCED is a product of international agreement and adopted formally by the General Conference of UNESCO Member States" (UNESCO[16], 2011)

The PISA 2015 Portuguese questionnaires use ISCED-1997 classification, the correspondence to Portuguese Cycles is:

ISCED 0 - Early childhood education

ISCED 1 – Primary Education, equivalent to 6 years of formal schooling (1st and 2nd cycles)

ISCED 2 - Lower secondary, equivalent to 9 years of formal schooling (3rd cycle)

ISCED 3 – Upper secondary, equivalent to 12 years of formal schooling (Portuguese secondary education)

ISCED 3A – General Curriculum

ISCED 3B/3C – Vocational or Technological Curriculum

ISCED 4 – Post-secondary and non-superior education (Technological Specialisation Degree)

ISCED 5A – 2nd cycle of superior education (pre-Bologna undergraduate or master's degree)

ISCED 5B – 1st cycle of superior education, equivalent to 3 years (post-Bologna undergraduate)

ISCED 6 – Advanced Superior Education (doctorate programmes)

Appendix D: Correlation Matrixes

Space restrictions prevent the full presentation of the correlation matrixes here. It is available from the Author upon request and also accessible online (https://drive.google.com/open?id=1pMts4NNLNEU4DKc6jttWUAhVGvieom0v).

[16] Retrieved from: http://unesdoc.unesco.org/images/0021/002116/211619e.pdf